ACCREDITATION OF BIOMEDICAL ENGINEERING PROGRAMS IN EUROPE – CHALLENGE AND OPPORTUNITY

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Abstract- **Today, more than 100 universities and polytechnic schools in Europe offer educational programs in Biomedical Engineering at all academic levels, but without any international coordination of contents and required qualifications. Transnational mobility for education, training and employment is an essential objective of the European Union. Such mobility is difficult to achieve because of different national practices in education, training and employment and in recognition of outcomes and accreditation. Accreditation plays an important role in ensuring transnational mobility and employability, and offers the additional advantages of confidence for the employer that the employee has the necessary education, training and responsible experience, and confidence for the user of the service, e.g. patients, that those providing the service are effective and competent.**

In order to enhance the advantages of accreditation to biomedical engineers, it is essential that structures are set up enabling the comparability, compatibility and mutual recognition of BME degrees. National quality assessment and accreditation schemes have to be established where they do not yet exist, and they have to be harmonized, i.e. they need to satisfy those criteria which the European BME community will have to establish on a transnational basis and mutually agree upon.

Though accreditation in BME is extremely important and directly related to the issues of health care quality, defining internationally accepted criteria, minimum requirements and competencies is a rather challenging task. Difficulties result from the vast diversity of partially incompatible educational systems, but also from the exceptionality of the young, highly dynamic discipline of Biomedical Engineering which offers a whole range of different qualifications and directions, related to various engineering specialty matters and which, as a part of the so-called life sciences, is reaching far into neighboring sciences such as medicine, biology and biochemistry. Adding to the problem are the many established academic programs within the classical engineering disciplines offering specialization in BME up to different levels of qualification or competency.

Keywords – Accreditation, Biomedical Engineering, Academic Programs

I. INTRODUCTION

Accreditation of engineering, technology and applied science programs, i.e. the granting of the authority to an institution or program to provide qualified education in a specific subject matter by a competent body, is a well established procedure in many countries. Even in those parts of the world, where no accreditation agencies exist, the US American Accreditation Board for Engineering and Technology (ABET) with its global range of activities can provide the service of an accreditation-like evaluation offering recognition as "substantially equivalent" to an accredited program in the US. Continuing globalization of economies and science calls for harmonization of educational programs, especially within Europe, where mobility and thus mutual acceptance of professional degrees has become a major issue. At first glance, the easiest way to achieve such harmonization in Europe seems to be to just expand ABET's authority, or to establish ABET-like structures and procedures. In reality, however, it is not that easy. Difficulties result from the vast diversity of partially incompatible educational systems, as well as from the exceptionality of the young, highly dynamic discipline of Biomedical Engineering which offers a whole range of different qualifications and directions, related to various engineering specialty matters and which, as part of the so-called life sciences, is reaching far into neighboring sciences such as medicine, biology and biochemistry. Adding to the problem are the many established programs within the classical engineering disciplines offering specialization in BME up to different levels of qualification or competency.

II. OUTCOME BASED ACCREDITATION

A crucial issue in setting up accreditation procedures has so far been the establishment of minimum requirements for BME programs. These have to include educational prerequisites for entering a BME program, course duration, basic and advanced biomedical engineering topics including mandatory and optional subjects, the ratio of lectures/practice/laboratory work and the minimum requirements for the independent work of the student. Due to the diversity and incompatibility of the various national educational systems, such an approach would, however, be obsolete from the beginning, if international harmonization and mutual recognition of degrees are taken into account. As a solution to this problem, accreditation must be outcome or competency based. Instead of imposing curricula, courses, duration and prerequisites to enter the programs, the outcome, i.e. the aptitude of students graduating from these programs will be the factor deciding on accreditation. Nevertheless, recommendations still need to be established for

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topics, courses and other contents of educational programs in order to achieve the required outcome. It is this approach to accreditation of academic programs that ABET has recently adopted, too.

The necessary skills can be grouped into the categories (1) basic science and engineering including engineering design, manufacturing and construction technologies, (2) important general skills (so called soft skills) such as the abilities for interdisciplinary team work, technology management, business and economics, quality control, professional ethics, creative thinking, cultural, social, economic and political effects of technology, and finally, of course, (3) the biomedical engineering skills and training necessary to qualify for a degree.

The specific competencies to be acquired in biomedical engineering depend on the degree and the specialization. Lists of topics have to be agreed upon that specify the necessary combinations of basic knowledge including such areas as anatomy, physiology, cell biology, biophysics, biochemistry, biotechnology, basic BME topics such as medical instrumentation, biomaterials, biomechanics, and the many advanced topics like diagnostic and therapeutic procedures, medical imaging systems and image processing, biomedical signal processing, artificial organs, bio-statistics, medical physics, cellular and tissue engineering, etc. Due to the enormous range of the different working areas in medical and biological engineering and the large variety of professions, each with different requirements regarding competencies, there cannot be a single list of topics with minimum aptitudes in the individual areas of BME, but a whole range of different competency profiles, each of course requiring a specific curriculum, and each tailored to the particular academic and professional level as well as the specialty area needs to be developed. Additionally, there should be room enough to permit the educational institutions to maintain specific, local identities. International harmonization or at least mutual recognition of degrees between individual countries or within larger areas such as the European Union requires that all parties involved agree upon the competency profiles. Getting to a broad international agreement on competency profiles might be relatively easy for traditional professions, it will, however, require major efforts and compromises for a discipline like BME which is well established in some countries, but only emerging in others, and that is expanding at an amazing speed.

The nature and rapid development of the field of biomedical engineering and the resulting variety of professional profiles requires the definition of the various levels of competency, i.e. a number of broadly accepted criteria, depending on the specific professional or technical, undergraduate, graduate or Ph.D. degree, or speaking in terms of future European structures, one, two or three cycle programs. Prerequisite, of course, is the exact definition of the range of BME, which by itself is pretty difficult, and requires permanent updating.

III. THE EUROPEAN SITUATION

Though much of our interest is directed towards global harmonization of educational standards, the current focus of activities must be on European BME accreditation. Europe is changing at a very fast pace politically, economically and socially and, naturally, science and education are fundamentally influenced by these developments. Traditional European structures of education, research, and research funding, which are strictly national issues, are becoming more and more obsolete in a unified and harmonized Europe where mobility is mandatory, and need to be replaced or at least supplemented by structures providing the compatibility of systems. Future developments are determined right now and that does apply to biomedical engineering, its future development and its significance, too. It is imperative, that the European community of biomedical engineers is participating decisively in any and all decisions touching their profession, and it has to be ensured that these decisions are not made by others without regard to our interests. It must also be made sure that the evolving system includes or at least remains open to those countries which are not or not yet members of the EU. Therefore, all European societies representing biomedical engineering, medical physics, clinical engineering, medical informatics, artificial organs, biomaterials etc. must address the related issues and must work together to realize the required changes in a way that is beneficial to our profession and thus to society. In response to the political requirements, which are most appropriately characterized by the Bologna Declaration, the European BME community must address the issues of higher education, i.e. quality control, harmonization, and accreditation.

IV. EUROPEAN ACCREDITATION STRUCTURES

The current European situation regarding quality control of educational programs is characterized by the existing organization according to ISO 9000, while at the horizon we have the competing and/or supplementary organization of Quality Assurance and European Harmonization of University Programs complying with the Bologna declaration. With the ISO 9000 structure, the European Commission is responsible for questions of quality on the European level. On the national level, the authority is with the national accreditation councils. The accreditation council recruits or nominates and accredits the accreditation agency/authority/institution which is responsible for the accreditation of academic programs. The accreditation agency is internally organized in so-called sector committees, which are responsible for the individual disciplines or professions. As the ISO 9000 structure is increasingly considered less important or even obsolete for the future, it is the structure for Quality Assurance and European Harmonization of University Programs that will be developed politically to take over all or at least the main responsibility for questions of education, accreditation and certification. In this structure, the European Commission as the responsible

body for quality control will be replaced by a council or an association of the national bodies/ministries for education (and research in most cases), which is actually the body that authored the Bologna declaration.

With the given structures, which at this time do not have any BME representation, at least on the European level, it becomes apparent where and how the BME societies or a recommendable European Federation of BME Societies and its national member societies will have to become involved. Unless the national societies set up their own accreditation agencies, they have to become members of or be represented in the responsible accreditation agencies, and should – possibly through these agencies – be represented in the national accreditation councils, whereas a future umbrella association of European BME Societies, whatever the name and structure may be, has to provide the input to the European Commission (ISO 9000) and the assembly or association of national ministries in the evolving new structure. It seems obvious that with the acceptance of the BME societies in the national and European bodies, which are responsible for education, accreditation and certification, the doors will also be open for further input to the European Commission regarding research funding in the field of Biomedical Engineering, which is one of the main goals of the current European BME initiatives.

A European Ad-Hoc Committee of the International Federation for Medical and Biological Engineering (IFMBE) is currently evaluating the diversity of existing BME programs and their situation with regard to accreditation throughout Europe, and will, in cooperation with the European member societies of IFMBE and other professional/scientific societies with an interest in BME, develop recommendations for accreditation criteria to be applied throughout Europe for a harmonized accreditation of all different types of biomedical engineering programs.

V. CRITERIA FOR ACCREDITATION

The IFMBE Ad-Hoc Committee has accepted the challenge to establish recommendations for accreditation criteria to be applied by pure and interdisciplinary BME programs within the new European framework of harmonized one and two cycle educational programs. To be internationally acknowledged, accreditation relies on ambitious, but broadly accepted criteria.

With its recommendations IFMBE is providing its European national member societies, the European universities and other institutions of higher education that offer BME programs a uniform guide to comply with the necessary international harmonization of higher education, to secure and to further improve the high quality of European BME education, to allow comparability of European BME qualifications and degrees, and thus to contribute to mobility for education, training and employment. The recommendations are intended to directing the attention of institutions of higher education and of governmental educational authorities to the essential contents of biomedical engineering education and thus to promoting European competitiveness in this dynamic discipline. The recommendations specify the criteria for accreditation including qualifying programs, degrees, minimum requirement in terms of competencies, organizational requirements, faculty and quality of teaching, administration, resources and facilities, and the consequences of these criteria for the accreditation process, particularly the involved evaluation procedures.

The accreditation criteria are based on the general goals of biomedical engineering education in one and two cycle programs at Universities, Universities of Applied Technology and Polytechnic Schools, considering a BME program as a scientifically based, fundamentals, application or research oriented study, that on the basis of broad knowledge of biomedical engineering and extensive competency of engineering methodology teaches and promotes the analytical, creative and design competencies for the development of concepts for solving engineering problems and for the development and improvement of biomedical systems and methods. Additionally, general competencies acquired by the students such as creative thinking, abilities for interdisciplinary work, technology management, business administration and economics, quality control and social competencies, e.g. ability for teamwork, professional ethics, cultural, social, economic and political effects of technology are important criteria for the accreditation of biomedical engineering programs.

VI. CONCLUSION

BME accreditation is expected to have major beneficial effects on the profession of Medical and Biological Engineering with regard to professional qualification, employability in a global world, collaboration between healthcare providers, industry and universities, and the establishment of international research networks. However, in order to arrive at these desirable effects, coordinated and focused actions on national, European and global levels are required.

VII. ACKNOWLEDGEMENTS

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